EMG Analysis of Exaggerated Hip Rotation on Anaerobic Power During Sprint Cycling

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Abstract

The purpose of the pilot test was to determine if the addition of hip rotation can affect lower body anaerobic power during sprint cycling and to test methods for a larger study. Four (n = 4) untrained subjects performed a Wingate Anaerobic Test for 30 seconds using standard cycling technique (ST) on one day and on another day, subjects switched to hip rotation (RT) for the final 15 seconds. Subjects were fitted with electrodes, which were used to analyze electromyography (EMG) data. EMG data was collected and analyzed using Biopac MP36 Systems. Mean anaerobic power, fatigue index, peak power and minimum power were analyzed with SMI Power software. EMG data was analyzed between ST and RT at the four locations of electrode placements. The EMG data appeared to show differences in muscle activity that could be related to differences in muscle activation requirement between the RT and ST tests.

Introduction

Anaerobic power is an important component in athletic performances such as in sprint running or sprint cycling and is commonly measured using the Wingate Anaerobic Test (WAnT). The WAnT is typically performed on a stationary cycle with the subject pedaling as fast as possible for 15 to 30 seconds against a pre-determined resistance or load. The test is considered supramaximal in that it is of short duration and high-intensity where the energy derived to perform it pre-dominantly comes from anaerobic bio-energetic sources. Typical measures obtained include peak, mean and minimum anaerobic power (Watts) as well as the fatigue index, or the percentage of power lost from start to finish. As the test is normally performed on a cycle ergometer, the movements are hip and knee extension and ankle plantar flexion during the push phase and hip and knee flexion, and ankle dorsiflexion during the pull phase. Moreover, hip and knee extension and flexion movements both increase with increasing power output, with the hip providing the most power during sub-maximal and supramaximal cycling (Elmer, Barratt, Korff and Marting, 2011, Korff T, Romer LM, Mayhew I, Martin JC, 2007, Mornieux et al. 2008). Although, the basic movements of cycling are in the sagittal plane, the hip moves in horizontal plane as well and therefore, contributions by muscles moving in this plane may create additional power.

Methods

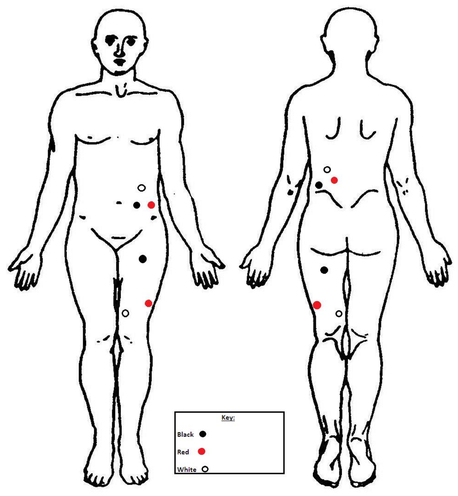
Subjects. Four subjects (n = 4) (2 males and 2 females) between the ages 19 and 21 (Table 1) from Morehead State University, volunteered for the study. No subjects were trained cyclists.

Instrumentation. A Monark Ergomedic 874E Ergometer with foot straps was used for all cycle tests. The SMI Power System and Biopac Systems MP36 were used to measure rotation and perform power calculations. Flywheel rotation was measured by a mounted laser that senses reflective markers placed on the flywheel. Peak, mean and minimum power were calculated as was the fatigue index (the percent change in power from peak to minimum power for the final 15 seconds). All power was corrected for flywheel inertia.

Procedures: Each subject performed the Wingate Anaerobic Test (WAnT) twice on non-consecutive days to ensure full recovery. On one day subjects used ST and on a different day subjects used RT. A counter-balanced design was used to avoid an order effect. On each testing day, subjects were weighed prior to testing to determine the proper resistance (load) to be added (7.5% of the subject's weight in kg). Seat height was adjusted for each subject allowing for knee flexion between 7 and 10% during extension at the "bottom" of the down stroke. The seat position was noted for the second test. Electrodes were placed at the four locations for EMG analysis (shown in Figure 1). Each subject then performed a two-minute warm-up with no-load. Following the warm-up and a 2-minute recovery, each subject performed a 10-second countdown at no-load while gradually increasing pedaling speed to maximum by the last 2-3 seconds of the countdown. At the end of the countdown the load was applied quickly by "dropping" a weight tray loaded with the pre-determined amount of weight plates. Each subject then pedaled all-out for 30 seconds, remaining seated throughout. A 2 to 5-minute low to no load cool-down was performed following the test.

Rotation Cycling. Rotation technique involved rotating or "swiveling" the hips by pointing the knees at a mark on the center post of the ergometer. Subjects internally rotated during the push phase and externally rotated during the pull phase. All subjects started the test using standard technique (ST). At the 16 second mark, subjects were instructed to switch to RT for the final 15 seconds.

Figure 1. Electrode Placements



Results

Table 1 shows descriptive statistics of subjects. Table 2 shows basic descriptive statistics of the data collected. Figure 2 shows the mean power output (watts) of the subjects in the final 15 seconds of both WAnT attempts. Figure 3 is an example of the Biopac MP36 EMG output. . No statistical analysis was conducted on any of the data due to the small sample size (n = 4).

Table 1. Descriptive Subject Data, Mean ± SD

Age (yrs)	21.0	±	2.0
Height (m)	1.7	±	0.1
Weight (kg)	72.3	±	16.0

Table 2. Descriptive Data for RT and ST

Means ± SD	RT			ST		
Fatigue Index (%)	17.0	±	6.6	9.9	±	10.3
Fatigue Index (%) (Final 10 sec)	4.9	±	5.5	8.6	±	11.2
Peak Power (Watts)	776.0	±	186.1	744.0	±	258.0
Mean Power (Watt)	671.8	±	114.3	658.0	±	232.5
Minimum Power (Watt)	573.5	±	78.5	559.5	±	235.3
Overall FI (%) (30 sec)	25.2	±	7.5	15.8	±	13.7

Figure 2. Mean Power for Final 15-Second for RT and ST Cycling.

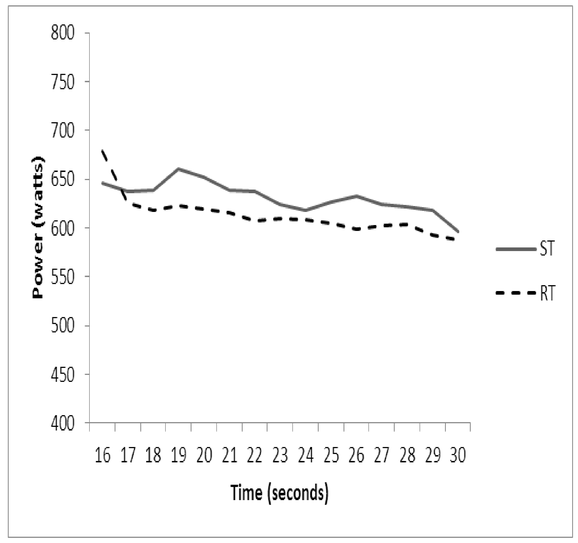
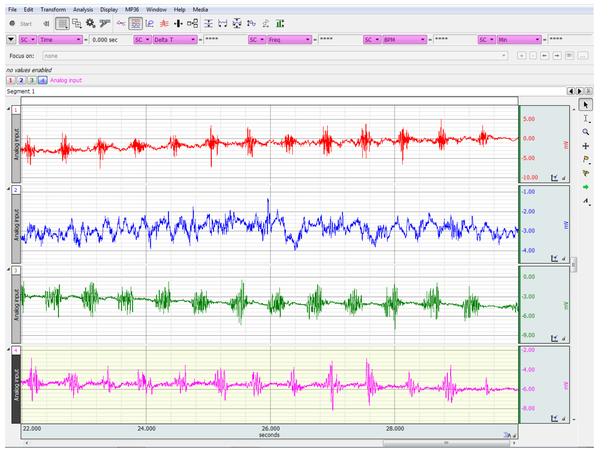


Figure 3. Biopac MP36 EMG Data Output



Discussion

Although no statistical analysis was conducted on this pilot study, the results of the study appear to show that exaggerated hip rotation may add to anaerobic lower body power during sprint cycling in untrained subjects. This may be beneficial to the cyclist in that power and pedal rotation can be maintained without having to stand up. EMG data appeared to have a clean output but lacked consistency between the four subjects. Further research should be performed on subjects with more cycling training. Considerations should be taken in choosing locations for electrode placements that may produce less interference from other muscles. Larger sample sizes are required to effectively run statistics.

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